A2575-23

Aboveground Storage Tank Survey

Health and Environmental Affairs Department

PUBLICATION NUMBER 0001
APRIL 1989

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Petroleum
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EXECUTIVE SUMMARY

This technical report describes the results of the Aboveground Storage Tank Survey conducted for the American Petroleum Institute by Entropy Limited. The survey covers all segments of the petroleum industry, namely marketing, refining, transportation and production. A total of 76,708 tanks were counted, including 75,369 tanks in the API field survey plus 1339 additional tanks in the marketing area from data supplied by the Petroleum Marketing Association of America (PMAA). This survey does not include what is believed to be a small part of the total tank population such as tanks at user locations (e.g., utility fuel storage). Based upon statistical analysis of these surveyed tanks into stratification groups, the total number of tanks nationally is estimated at approximately 700,000. This includes approximately 89,000 in marketing, 30,000 in refining, 9,000 in transportation and 572,000 in production. Table S-1 shows the number of tanks and their total shell capacity by industry sector.

Table S-1. National estimates by industry sector, number of tanks and total shell capacity.

	Number Tanks	Total Shell Capacity (MBbls)
Marketing	88,529	486,925
Refining	29,727	945,092
Transportation	9,197	556,183
Production	572,620	280,595
	700,073	2,268,795

Tank sizes, ages and other characteristics are covered in the survey. Table S-2 shows the estimated distribution of tanks nationally by industry sector and size. The largest portion (82.8%) comprises the smallest size category, 26 to 500 Bbls. The next largest portion (6.4%) is the 500 to 1000 Bbls size range. Only 0.6% of the tanks are over 100,000 Bbls.

Table S-2. National estimates by industry sector, numbers of tanks by shell capacity (bbls).

	26 to 500	+500 to 1 M	+1 M to 10 M	+10 M to 100 M	+100 M
Marketing	64,793	4,417	7,434	11,469	416
Refining	3,913	2,460	9,665	11,629	2,060
Transportation	694	307	1,468	5,048	1,680
Production	510,045	37,628	23,946	974	27
	579,445	44,812	42,513	29,120	4,183

For tanks of known ages, the largest portion (32.1%) comprises the 0-10 year age range. The next largest (26.6%) is the 11-20 year range. Table S-3 gives the age distributions by industry sector as well as the national total age distribution.

Table S-3. National estimates by industry sector, numbers of tanks by age (years).

	0-10	11-20	21-30	31-40	41+	Unkn
Marketing	9,583	13,465	21,167	15,578	21,149	7,587
Refining	2,066	3,446	4,814	6,877	11,129	1,395
Transportation	876	1,376	1,831	2,096	2,666	352
Production	212,440	167,863	112,131	28,865	13,109	38,212
	224,965	186,150	139,943	53,416	48,053	47,546

The survey also covers type of material contained in the tanks and type of tank construction. Detailed breakouts by material and construction types for each industry sector are given in the corresponding sections of this report.

The figures for distance from navigable waters were also surveyed. Totalling the numbers of facilities in marketing, refining and transportation, 48.8% are over 5 miles, 20.1% are 1 to 5 miles, 7.8% are 1/2 to 1 mile, 7.4% are 1/4 to 1/2 mile, and 15.9% are less than 1/4 mile from navigable waters. For production, 23.9% of the tanks are over 5 miles, 21.0% are 1 to 5 miles, 14.5% are 1/2 to 1 mile, 15.0% are 1/4 to 1/2 mile, and 25.6% are less than 1/4 mile from navigable waters.

In the estimated national totals, the percentage of facilities covered by SPCC regulation (40CFR112) is 91.6% for marketing, 100% for refining, and 37.3% for transportation. The percentage with written spill contingency plans is 96.0% for marketing, 97.6% for refining and 79.7% for transportation. In production, these figures were tabulated on a tank basis, with 58.2% of the tanks covered by SPCC plans, and 47.6% covered by written spill contingency plans. The bulk of transportation facilities are not covered by SPCC regulations, but are covered by DOT oil spill contingency regulations.

MARKETING

There are an estimated 88,529 aboveground storage tanks at marketing sites in the U.S. representing the total demand for petroleum products, including motor gasoline, jet fuel, distillates, residuals and other. To achieve this estimate, API survey data has been supplemented with marketing facility surveys from the PMAA. The data supplied by PMAA members (Table M-4b) are incomplete in some respects, so that they have not been combined with the API marketing totals (Table M-4a). Valid surveys from API companies were received for 395 facilities while results from an additional 169 facilities were obtained through the PMAA.

In order to obtain a reliable estimate of total U.S. tankage, it is necessary to stratify the sample. Unstratified extrapolation based on sales figures, which are 116,659 MBbl/Month for the 395 API survey respondents and 17,131 MBbl/Day nationally as of the end of 1986*, would produce an underestimate because of the distribution of survey respondents by sales. Unstratified extrapolation based on number of facilities, which is 395 for the API survey and 12,424 for the nation as a whole (the 1982 Census of Wholesale Trade estimates the number of bulk plants and terminals at 10,131 and 2,293 respectively--LP gas facilities excluded), would produce an overestimate because the API survey has a disproportionate number of large terminals, which tend to have a high number of tanks per facility (see Table M-2).

Stratification of the components of the tankage by type of material is not possible because of differences between the portions categorized as heavy oils in national data definitions and the portions so categorized in the survey responses. Of course, it would be necessary to separate aboveground from underground storage capacity, and this generally precludes using this factor for the stratification.

Stratified estimation is possible by keying against total facility storage capacity. Storage capacity in the national census technically includes both AST and UST storage. However, virtually all storage at terminals and roughly 90% of bulk plant storage is above ground. Stratification is based on five facility storage capacity groups: below 2,500 Bbl, 2,500 - 24,999 Bbl, 25,000 - 149,999 Bbl, 150,000 - 499,999 Bbl, and 500,000 Bbl and above.

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* "1987 Energy Statistics Sourcebook," p. 239.

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Table M-1 gives the estimation of AST's based on these groupings. API and PMAA survey responses are combined to achieve better coverage in all five groups.

Table M-1

Extrapolation of survey tanks to U.S. totals (API and PMAA data)

Facility Group Total Facility Storage	Survey Storage Capacity (MBbl)	National Storage Capacity* (MBbl)	Survey Tanks	Estimated National Tanks* (AST and UST)	Estimated National Tanks (AST only)
(1) below 2.5 MBbl	168.1	7,865	637	29,804	26,824
(2) 2.5 - 24.9 MBbl	646.5	39,041	780	47,103	42,393
(3) 25 - 149.9 MBbl	12,770	95,654	1,034	7,745	7,745
(4) 150 - 499.9 MBbl	43,984	141,803	1,649	5,316	5,316
(5) 500 MBbl and above	57,305	206,951	1,731	6,251	6,251
Totals	114,874	491,314	5,831	96,219	88,529

*National storage capacity and national tank estimates include underground storage tanks (UST's) as well as AST's. Removal of the UST population is discussed below.

The representativeness of the current survey is given in Table M-2 in terms of percent of facilities and percent of storage capacity.

Table M-2

Representativeness of current survey (API and PMAA data)

Facility Group	National number of facilities	Surveyed number of facilities	Surveyed facilities (% of U.S.)	Surveyed capacity (% of U.S.)
(1)	5,317	121	2.3 %	2.1 %
(2)	4,917	81	1.6	1.7
(3)	1,480	145	9.8	13.4
(4)	525	160	30.5	31.0
(5)	185	57	30.8	27.7
Totals	12,424	564	4.5	23.4

Table M-3 characterizes the groups in terms of per tank thruput and capacity for the survey data.

Table M-3

Characteristics of stratification groups

Facility Group	Tanks/ facility	Thruput** (MBbl/D) per tank	per facility	Capacity (MBbl) per tank	per facility Survey	per facility U.S.	Thruput** per Capacity (Bbl/Bbl-D)
(1)	5.2	1.6*	9*	0.3	1.4	1.5	4.99*
(2)	9.6	7.3*	33*	0.8	8.0	7.9	2.34*
(3)	7.1	23.7	163	12.3	88.1	64.6	1.83
(4)	10.3	32.8	346	26.7	274.9	270.1	1.26
(5)	30.4	24.7 (API only)	763 (API only)	33.1	1005.4	1118.7	0.77 (API only)

*Throughput data for some of the facilities in the groups (1) and (2) have been estimated.

**All throughput data and throughput per capacity ratios are derived from API survey respondents only.

The capacity per facility ratio for the survey closely matches Census Bureau data for the U.S. Group (2) exhibits an anomalously high value for tanks per facility. In this respect, the API and PMAA samples differ, PMAA data exhibiting a higher ratio.

An estimated adjustment to exclude UST's from the extrapolation can be achieved by reducing the U.S. tank totals by 10% for the bulk plant subpopulation. This subpopulation approximately coincides with groups (1) and (2), which jointly consist of 10,234 U.S. facilities. From Table M-1, 10% of the group (1) and (2) tanks equals 7667.3. Reducing the overall U.S. totals by this amount gives an adjusted total of 88,318 above ground storage tanks.

Table M-4 contains the survey totals for (a) API and (b) PMAA marketing facilities, respectively. Note that PMAA data were surveyed for only the two tank size ranges 25-1000 Bbl and over 1000 Bbl. National estimates for marketing tank populations are presented in Table M-5.

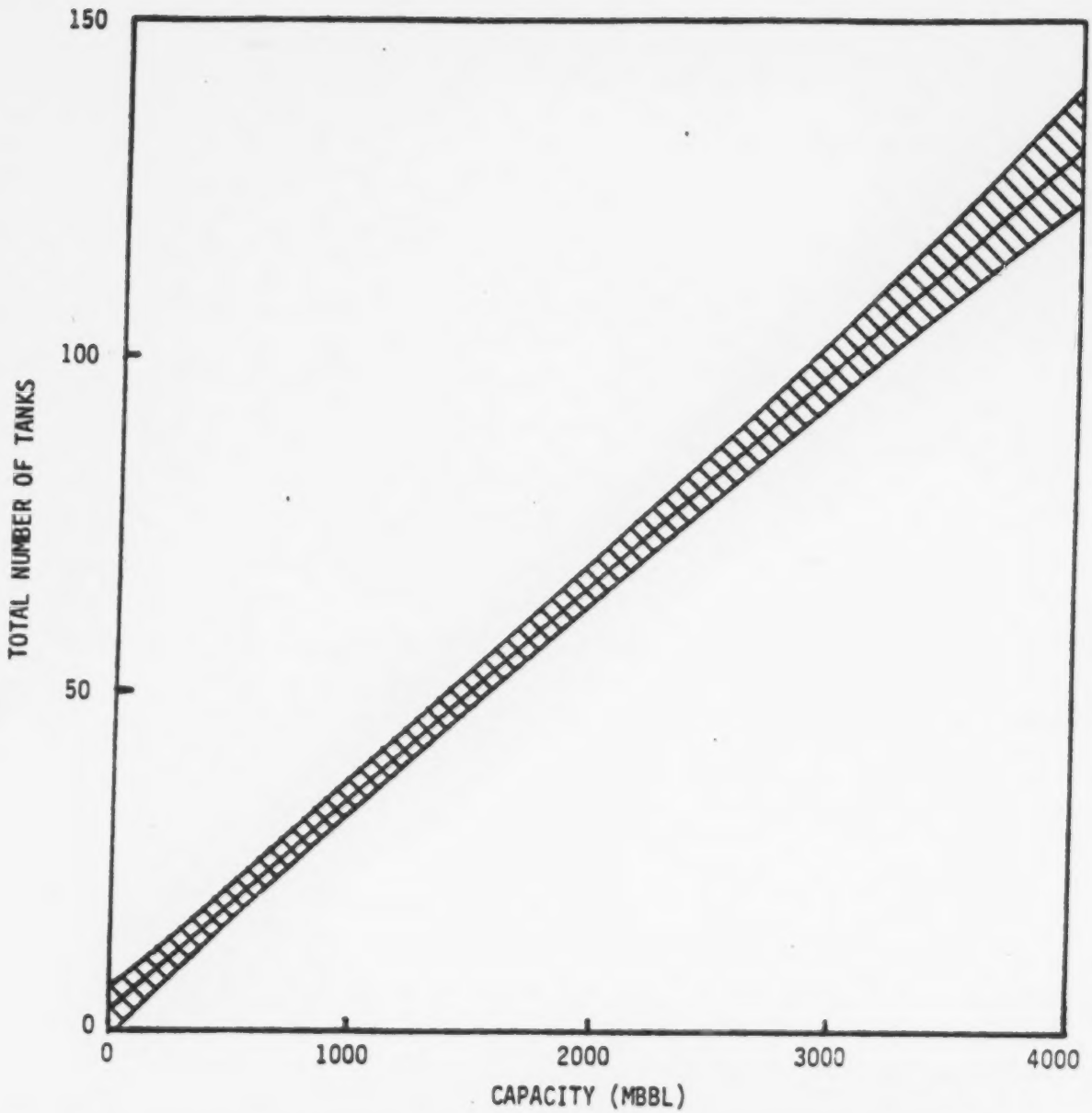

Figure M-1. Linear trend line and its uncertainty in fitting the number of aboveground storage tanks versus facility storage capacity for 395 marketing facilities.

Table M-4a

Survey totals for MARKETING (API only)

Form completed by _____ Title _____

Company _____ Phone _____

Mail address _____ City _____ State ____ Zip _____

Facility name & address _____ City _____ State ____ Zip _____

Total monthly thruput (thousands of barrels out of facility) 116,659

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	395	Petroleum transportation	____
Petroleum refining	____	Utilities	____
Petroleum production	____	Chemical manufacturing	____
Other (specify):	____		

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
148	Viscous heavy oils	35	25	40	48	0	0	1,913
47	Fluid heavy oils	9	3	21	12	2	0	1,039
347	Lube oils (not viscous)	157	80	79	31	0	0	99
1242	Distillates	143	28	222	805	44	0	37,485
1896	Gasolines	227	27	278	1299	65	0	57,646
48	Non-potable water	9	3	23	13	0	0	403
287	Non-operational tanks	116	23	81	65	2	0	2,847
477	Other:	189	30	94	163	1	0	5,780
4492	Total	885	219	838	2436	114	0	108,109

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
30	Elevated	6	1	13	2	5	3
34	Reconstructed	4	11	9	2	8	0
135	Shop fabricated	61	16	27	17	6	8
907	Riveted/bolted (in field)	10	3	9	41	692	152
3167	Welded (in field)	163	405	788	1058	569	184
4273	Total	244	436	846	1120	1280	347

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment:		R	S
Pipe line	____	283	69
Rail car	____	13	9
Marine vessel	____	75	29
Truck transport	____	91	337
Other (specify):	____	1	1

Distance to navigable waters:	
less than 1/4 mile	132
+1/4 to 1/2 mile	32
+1/2 to 1 mile	35
+1 to 5 miles	62
over 5 miles	100

5. Is this facility covered by SPCC regulations (40CFR112)? yes 372 no 19

6. Does this facility have a written spill contingency plan? yes 391 no 2

Form 05/13/88

Survey totals for MARKETING (PMAA members)

Form completed by _____ Title _____
Company _____ Phone _____
Mail address _____ City _____ State ____ Zip _____
Facility name & address _____ City _____ State ____ Zip _____
Total monthly thruput (thousands of barrels out of facility) Insufficient Data

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	169 (PMAA only)	Petroleum transportation	
Petroleum refining		Utilities	
Petroleum production		Chemical manufacturing	
Other (specify):			

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 1000 (# tanks)	1000 to 10M (# tanks)	over 1000 (# tanks)	10M to 100M (# tanks)	10M to 50M (# tanks)	50M+ (# tanks)	Total Capacity (MBbls)
12	Viscous heavy oils	3		9				367
24	Fluid heavy oils	10		14				581
226	Lube oils (not viscous)	211		15				909
575	Distillates	480		95				3,506
405	Gasolines	359		46				1,362
0	Non-potable water	0		0				0
83	Non-operational tanks	75		8				42
14	Other:	14		0				5
1339	Total	1152		187				6,772

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
346	Elevated	31	74	63	54	111	13
50	Reconstructed	8	0	11	12	13	6
564	Shop fabricated	86	86	172	71	71	78
79	Riveted/bolted (in field)	0	1	15	4	56	3
260	Welded (in field)	26	45	65	64	29	31
1299	Total	151	206	326	205	280	131

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment:		R	S
Pipe line		15	3
Rail car		1	0
Marine vessel		7	0
Truck transport		142	144
Other (specify):		1	5

Distance to navigable waters:	
less than 1/4 mile	23
+1/4 to 1/2 mile	11
+1/2 to 1 mile	10
+1 to 5 miles	30
over 5 miles	70

5. Is this facility covered by SPCC regulations (40CFR112)? yes 139 no 18

6. Does this facility have a written spill contingency plan? yes 156 no 10

Form 05/13/88

Table M-5. Estimated U.S. AST's for MARKETING

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	11305	Petroleum transportation	
Petroleum refining		Utilities	
Petroleum production		Chemical manufacturing	
Other (specify):			

2. Record the number of above ground tanks at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
1068	Viscous heavy oils	281	144	399	243	1	0	9868
896	Fluid heavy oils	460	25	267	135	9	0	7092
10732	Lube oils (not viscous)	9300	834	393	202	3	0	11007
35287	Distillates	26683	1680	2880	3884	160	0	176143
32003	Gasolines	22250	1328	2159	6034	232	0	246415
287	Non-potable waste water	43	10	184	50	0	0	1771
5776	Non-operational tanks	4403	251	782	333	7	0	13531
2480	Other:	1373	145	370	588	4	0	21098
88529	Total	64793	4417	7434	11469	416	0	486925

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
19459	Elevated	1597	4533	3827	2915	5935	652
3037	Reconstructed	517	50	757	593	831	289
32364	Shop fabricated	5201	5068	9728	3929	4069	4369
8836	Riveted/bolted (in field)	506	78	644	413	6277	918
24833	Welded (in field)	1762	3736	6211	7728	4037	1359
88529	Total	9583	13465	21167	15578	21149	7587

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waterway.

Mode of receipt/shipment:		R	S	Distance to navigable waters:	
Pipe line		1985	524	less than 1/4 mile	1751
Rail car		111	44	+1/4 to 1/2 mile	819
Marine vessel		470	119	+1/2 to 1 mile	880
Truck transport		9070	10673	+1 to 5 miles	2384
Other (specify):		48	263	over 5 miles	5471

5. Is this facility covered by SPCC regulations (40CFR112)? yes 10360 no 945

6. Does this facility have a written spill contingency plan? yes 10855 no 450

REFINING

There are an estimated 29,727 aboveground storage tanks at refineries in the U.S. Of these, 54.7% are at large refineries, 28.5% are at medium sized refineries, and 16.7% are at small refineries.*

These estimates were obtained by comparing the capacity and thruput figures for 63 facilities in the survey to those for the 207 facilities reported in "United States Refining Capacity," National Petroleum Refiners Association, Wash., D.C., Jan. 1, 1988, pp. 31-34. These 207 include 182 operating refineries and 25 refineries which were idle at that time. This agrees with the figures reported in the Oil and Gas Journal, (March 21, 1988). This means that about 10% of the refinery tanks are non-operational, in agreement with the non-operational tank figures from the current survey (see Table R-3).

Figure R-1 shows a plot of the number of tanks per facility versus charge capacity for the refineries surveyed. Here, charge capacity is defined as the input (feed) capacity of the refinery processing facilities. Large, medium and small refineries in the survey averaged about 294, 126 and 82 tanks per facility, respectively. As is evident from this plot, the average number of tanks per facility has two components: a base line of about 65 tanks, independent of size, plus a size dependent component which is about 120 tanks per 100,000 Bbl/D charge capacity.

*For purposes of aligning the data in this survey with categories used by the Nat. Petrol. Refiners Assoc., the points dividing large/medium and medium/small were defined as 100,000 B/CD and 30,000 B/CD charge capacity, respectively.

Table R-1

Extrapolation of survey tanks to U.S. totals

Refinery Size Group	Survey Sample: Number Refineries	Survey Sample: Charge Cap. Per Refinery (Bbl/D)	Survey Sample: Total Tanks	U.S. Total: Number Refineries	U.S. Total: Charge Cap. Per Refinery (Bbl/D)	U.S. Total: Estimated Total Number of Tanks
Small	8	16,750	654	82	12,388	4958
Medium	32	63,561	4015	74	58,047	8479
Large	23	191,643	6771	51	207,929	16,290
Total	63	-	11,440	207	-	29,727

Table R-1 gives the number of refineries, the average charge capacity per refinery and the total number of tanks. These figures are given both for the survey sample and for the U.S. as a whole. The survey respondents included 30.4% of the nation's refineries, accounting for 41.3% of the charge capacity and an estimated 38.5% of the storage tanks.

The "large" refinery category contains 24.6% of the nation's refineries, accounting for 66.6% of the charge capacity and an estimated 54.8% of the aboveground storage tanks.

The "medium" sized category contains 35.7% of the refineries in the U.S., accounting for 27.0% of the charge capacity and an estimated 28.5% of the tanks.

The "small" refineries account for 39.6% of the refineries in the U.S., accounting for 6.4% of the charge capacity, and an estimated 16.7% of the tanks.

Tank count extrapolation without stratifying the refineries would underestimate the population. The stratified estimate of 29,727 is more accurate because it includes tanks from the small refinery category that would otherwise be underestimated. Some characteristics of the refinery groups in the data sample are presented in Table R-2.

Table R-2

Characteristics of the data sample

Refinery Size Group	Sample Size	Tanks per Refinery	Shell capacity per Tank (MBbl)	Charge capacity per Tank (Bbl/D)
Small	8	81.8	12.31	204.9
Medium	32	125.5	29.76	506.6
Large	23	294.4	35.01	651.0

From Table R-2, the small refineries are seen to have relatively fewer and smaller sized tanks. Also, the charge capacity per tank is not constant, varying by a factor of three from the small to the largest refinery group. Since the number of tanks nationwide is extrapolated on the basis of the represented charge capacity, the stratification into size groups is necessary to avoid underestimating the tanks located at small refineries.

Table R-3 contains the survey totals for the 63 refineries in the survey. National estimates for refinery tank populations are presented in Table R-4.

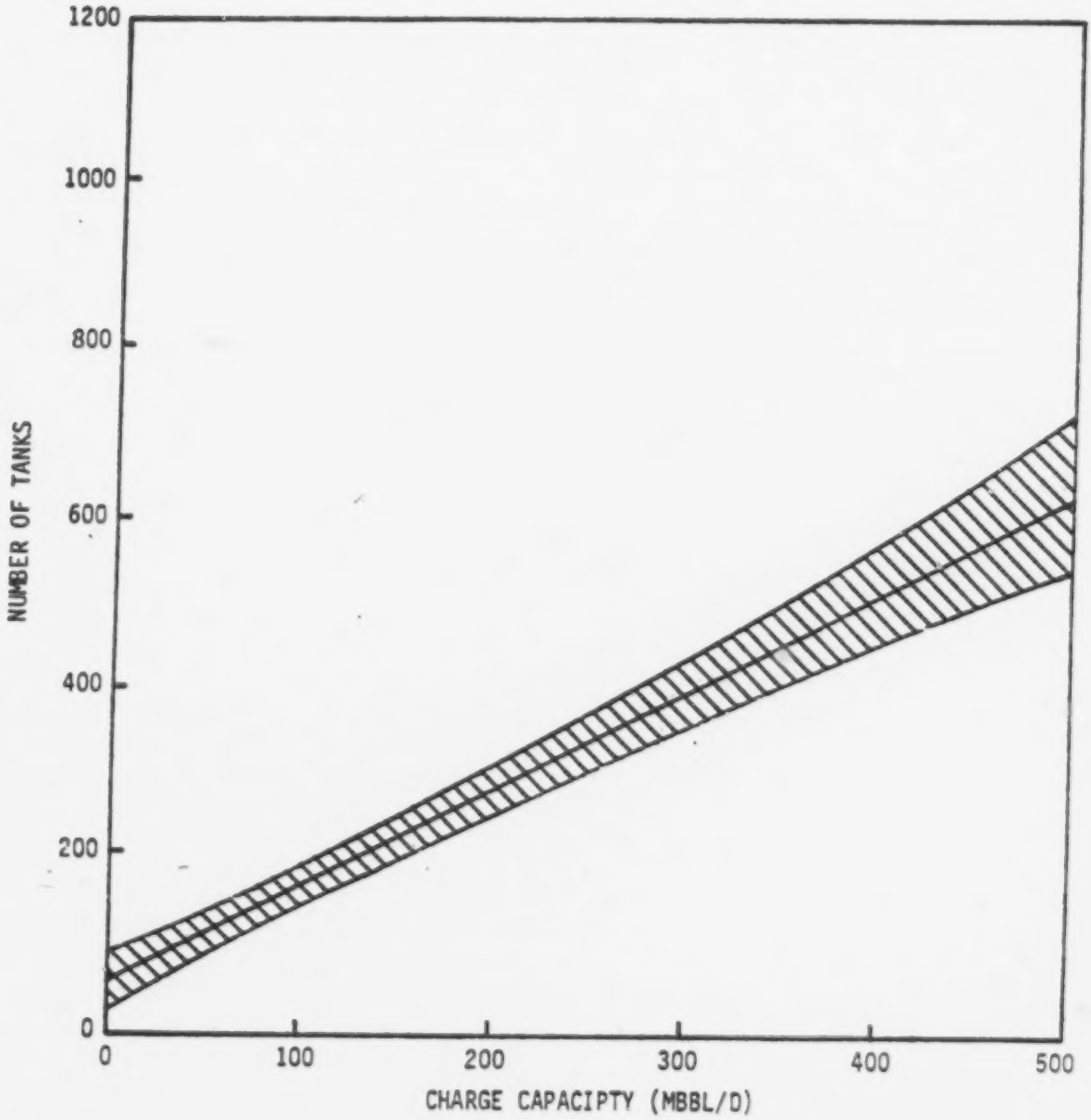

Figure R-1. Linear trend line and its uncertainty in fitting the aboveground number of storage tanks versus refinery charge capacity for 63 U.S. refineries.

Table R-3

Survey totals for REFINING

Form completed by _____ Title _____
Company _____ Phone _____
Mail address _____ City _____ State ____ Zip _____
Facility name & address _____ City _____ State ____ Zip _____
Total monthly thruput (thousands of barrels out of facility) 200,699

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	____	Petroleum transportation	____
Petroleum refining	63	Utilities	____
Petroleum production	____	Chemical manufacturing	____
Other (specify):	_____		

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
1054	Viscous heavy oils	39	65	358	494	97	1	43,043
1508	Fluid heavy oils	84	60	286	757	309	12	115,187
2112	Lube oils (not viscous)	501	223	873	515	0	0	16,423
1886	Distillates	55	69	432	1156	174	0	88,292
2020	Gasolines	88	83	408	1181	259	1	101,677
365	Non-potable water	33	25	150	154	3	0	6,667
1192	Non-operational tanks	154	145	681	206	6	0	11,342
1303	Other:	492	211	425	169	6	0	7,538
11,440	Total	1446	881	3613	4632	854	14	390,169

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
268	Elevated	24	60	17	54	79	34
585	Reconstructed	103	78	113	50	222	19
207	Shop fabricated	57	56	5	20	59	10
3351	Riveted/bolted (in field)	6	11	21	221	2968	124
6762	Welded (in field)	648	1084	1662	2366	847	155
11173	Total	838	1289	1818	2711	4175	342

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment:		R	S
Pipe line	____	53	55
Rail car	____	19	33
Marine vessel	____	33	34
Truck transport	____	27	40
Other (specify):	_____	0	1

Distance to navigable waters:	
less than 1/4 mile	34
+1/4 to 1/2 mile	3
+1/2 to 1 mile	5
+1 to 5 miles	6
over 5 miles	14

5. Is this facility covered by SPCC regulations (40CFR112)? yes 62 no 0

6. Does this facility have a written spill contingency plan? yes 60 no 0

Form 05/13/88

Table R-4. Estimated U.S. AST's for REFINING

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing		Petroleum transportation	
Petroleum refining	207	Utilities	
Petroleum production		Chemical manufacturing	
Other (specify):			

2. Record the number of above ground tanks at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
2873	Viscous heavy oils	215	207	1008	1208	233	2	102195
4222	Fluid heavy oils	263	227	960	2005	739	28	281170
5426	Lube oils (not viscous)	1294	597	2203	1332	0	0	42598
4914	Distillates	155	223	1247	2882	407	0	213225
5062	Gasolines	209	213	1078	2946	614	2	244576
915	Non-potable waste water	89	62	396	361	7	0	15711
2833	Non-operational tanks	388	350	1596	485	14	0	26693
3482	Other:	1300	581	1177	410	14	0	18924
29727	Total	3913	2460	9665	11629	2028	32	945092

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
876	Elevated	56	372	39	130	198	81
1404	Reconstructed	233	209	254	116	539	53
553	Shop fabricated	140	167	11	48	154	33
9339	Riveted/bolted (in field)	14	28	63	712	7948	574
17555	Welded (in field)	1623	2670	4447	5871	2290	654
29727	Total	2066	3446	4814	6877	11129	1395

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waterway.

Mode of receipt/shipment:		R	S	Distance to navigable waters:	
Pipe line		181	174	less than 1/4 mile	99
Rail car		63	110	+1/4 to 1/2 mile	8
Marine vessel		106	108	+1/2 to 1 mile	13
Truck transport		108	141	+1 to 5 miles	22
Other (specify):		0	2	over 5 miles	65

5. Is this facility covered by SPCC regulations (40CFR112)? yes 207 no 0

6. Does this facility have a written spill contingency plan? yes 202 no 5

TRANSPORTATION

There are an estimated 9,197 aboveground storage tanks associated with pipeline operations in the U.S. Of these, an estimated 8,107 tanks are associated with 142 interstate pipeline companies and an additional 1090 tanks are associated with 81 intrastate companies. Tank counts exclude natural gas liquids pipelines.

This estimate is based on the total tankage from 38 companies reported for 1,107 facilities. Of these companies, 29 are engaged in interstate operations and 9 only in intrastate operations. Information about pipeline mileage, deliveries and traffic for these companies was obtained from the most recent annual pipeline review article for the Oil and Gas Journal (True, 1987). For 1986, the 29 interstate companies in the survey comprised 61.6% of interstate mileage, 70.6% of all interstate deliveries and 75.8% of all interstate traffic although they are only 20.4% of the total number of interstate companies. The survey thus includes a high proportion of the nation's largest pipeline companies. The representativeness with respect to gathering lines, crude trunklines and products trunklines was assessed, the percentage being 62.6%, 69.1% and 55.6%, respectively. The data sample is roughly equally representative of these three types of interstate pipeline operations.

The number of tanks correlates well with total mileage as is seen from Figure T-1. To investigate the dependency of the number of tanks on miles of piplines operated, companies were stratified into three groups: "small" companies operating below 1000 miles of pipeline, "medium" companies with 1000-5000 miles, and "large" companies operating over 5000 miles. Some basic statistics for the year 1986 for the sampled companies in these groups are given in Table T-1.

Table T-1

Characteristics of the surveyed interstate pipeline operations

Groups	# of Co.s	Tanks	Capacity (MBbls)	Mileage (miles)	Deliveries (MMBbls)	Traffic (MMMBbls-miles)
(1) <1000 mi	9	188	9,396	4,038	611	72
(2) 1000-5000 mi	11	1,261	75,474	26,436	2,714	1,053
(3) >5000 mi	9	3,645	207,398	69,920	4,392	1,469

	Capacity/Tank (MBbl)	Mileage/Tank (miles)	Deliveries/Tank (MMBbl)	Traffic/Tank (MMBbl-miles)
(1)	50.0	21.5	3.25	383
(2)	59.9	21.0	2.15	835
(3)	56.9	19.2	1.20	403

The number of miles per tank is nearly the same for the three groups, and averages 20 miles per tank overall. It should be noted that the constancy of this factor is coincidental and not due to any inherent pattern of tank usage by the oil pipeline industry.

These numbers are compared against available data for all 142 interstate pipeline companies (with the sample fraction in parentheses) in Table T-2.

Table T-2

Characteristics of all 142 national interstate pipeline operations. The percentage captured by the survey is given in parentheses. Pipelines used to transport natural gas liquids have been excluded.

Group	# of Co.s	Mileage (miles)		Deliveries (MMBbl)		Traffic (MMMBbl-miles)	
(1) <1000 mi	105	24,114	(16.7%)	2,418	(25.2%)	527	(13.7%)
(2) 1000-5000 mi	26	58,333	(45.3%)	3,792	(71.6%)	1,342	(78.5%)
(3) >5000 mi	11	80,630	(86.7%)	4,715	(93.1%)	1,552	(94.7%)
Total	142	163,077	(61.6%)	10,925	(70.6%)	3,421	(75.8%)

The total number of tanks nationwide for the three groups is obtained by multiplying the tank counts in the survey by a scaling factor. For the reasons discussed above, mileage is used to generate the scaling factor for computing the estimate of national tanks for interstate pipeline operations. Table T-3 gives the national tank estimates by operations group.

Table T-3

Estimation of national tank populations by pipeline operations group. The scale factor is the reciprocal of the fraction of mileage captured in the survey given in Table T-2.

Group	Survey Tanks	Scale Factor	Estimated National Tanks
(1) <1000 mi	188	5.97	1,122
(2) 1000-5000 mi	1,261	2.21	2,782
(3) >5000 mi	3,645	1.15	4,203
Sub-Total	5,094		8,107
(4) Intrastate operations	297	(see text below)	1,090
Total	5,391		9,197

The number of intrastate tanks is computed based on the Department of Transportation Office of Pipeline Safety list of assessed payments received. The list, dated 2/19/88, includes company name, miles of pipe and amount assessed ($7.54 per mile). The assessment is applicable to all companies owning over 30 miles of regulated pipeline. When interstate and natural gas liquid pipelines are eliminated from the list, a total of 22,006 miles (out of 152,871 inter- and intrastate miles) from 81 companies remain. Applying the

basis of 20 miles/tank, which is the average value from 29 interstate pipeline operations in the current API survey, results in an estimate of 1,090 tanks associated with intrastate operations.

The estimate of 20 miles per tank was cross-checked by examining four tank companies in the survey engaged in intrastate operations. (Five other intrastate pipline companies operations could not be included either because DOT mileage was not available or because the survey information supplied by the company did not cover all of its pipeline operations.) The four companies which were included have 40 tanks and DOT regulated pipelines mileage of 801 miles, for a ratio of 20.03 per tank. This agrees well with the interstate operations estimate. The DOT list is likely incomplete since payments may not have been received from some companies. For interstate operations, the DOT list contains 103,865 miles, which is 80.2% of the total mileage given in the Oil and Gas Journal. If an adjustment of multiplying by 1.247 (=1/0.802) to account for incomplete DOT reportage were applied to intrastate tank counts, the intrastate estimate would be raised to 1,358.

Care should be exercised in interpreting the relatively high percentage of transportation sector survey respondents who state to have no SPCC or written spill contingency plan. Although a pipeline tankage facility may not have a specific spill contingency plan, it may likely be covered by a general spill plan required by DOT.

Table T-4 contains the survey totals for the operation of 38 pipeline companies responding to the survey. National estimates for pipeline tank populations are presented in Table T-5.

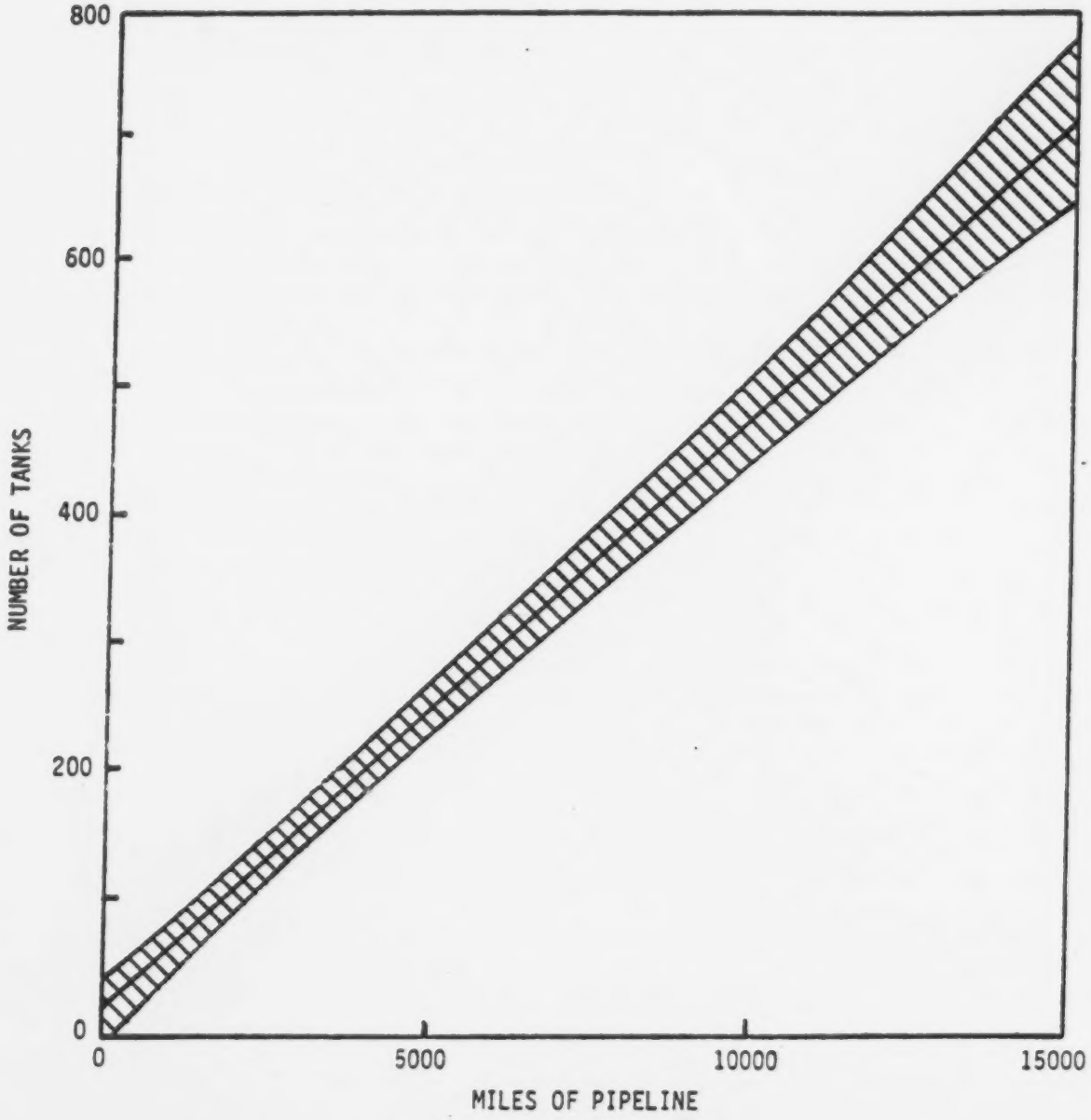

Figure T-1. Linear trend line and its uncertainty in fitting the number of aboveground storage tanks versus miles of interstate pipeline for 29 interstate locations.

Table T-4

Survey totals for TRANSPORTATION

Form completed by _____ Title _____
Company _____ Phone _____
Mail address _____ City _____ State ____ Zip _____
Facility name & address _____ City _____ State ____ Zip _____
Total monthly thruput (thousands of barrels out of facility) 832,594 (includes multiple-counting)

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	____	Petroleum transportation	1107
Petroleum refining	____	Utilities	____
Petroleum production	____	Chemical manufacturing	____
Other (specify):	_____		

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
232	Viscous heavy oils	14	3	24	129	61	1	18,449
2421	Fluid heavy oils	180	68	398	1275	498	2	160,657
8	Lube oils (not viscous)	0	0	0	8	0	0	490
1110	Distillates	52	21	142	755	140	0	57,792
1123	Gasolines	11	13	107	781	211	0	68,657
73	Non-potable water	11	7	27	28	0	0	1,023
193	Non-operational tanks	9	4	37	132	11	0	8,811
231	Other:	85	39	69	34	4	0	2,081
5391	Total	362	155	804	3,142	925	3	317,960

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
140	Elevated	5	3	14	93	25	0
280	Reconstructed	24	10	36	72	136	2
130	Shop fabricated	99	17	2	2	0	10
1252	Riveted/bolted (in field)	19	27	29	103	1012	62
3509	Welded (in field)	270	607	982	954	579	117
5311	Total	417	664	1063	1224	1752	191

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment:		R	S
Pipe line	____	898	950
Rail car	____	2	6
Marine vessel	____	22	22
Truck transport	____	172	34
Other (specify):	_____	0	0

Distance to navigable waters:	
less than 1/4 mile	194
+1/4 to 1/2 mile	128
+1/2 to 1 mile	84
+1 to 5 miles	162
over 5 miles	504

5. Is this facility covered by SPCC regulations (40CFR112)? yes 314 no 768

6. Does this facility have a written spill contingency plan? yes 842 no 243

Form 05/13/88

Table T-5. Estimated U.S. AST's for TRANSPORTATION

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	____	Petroleum transportation	2132
Petroleum refining	____	Utilities	____
Petroleum production	____	Chemical manufacturing	____
Other (specify):	____		

2. Record the number of above ground tanks at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material \ Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (#tanks)	Total Capacity (MBbls)
547	Viscous heavy oils	16	10	77	260	180	4	54769
4048	Fluid heavy oils	374	160	749	1941	822	2	255649
9	Lube oils (not viscous)	0	0	0	9	0	0	565
1862	Distillates	107	45	222	1232	256	0	101206
1858	Gasolines	23	22	144	1280	389	0	123758
155	Non-potable waste water	22	15	56	62	0	0	2404
322	Non-operational tanks	24	9	69	202	18	0	13939
396	Other:	128	46	151	62	9	0	3893
9197	Total	694	307	1468	5048	1674	6	556183

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction \ Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
324	Elevated	11	10	34	213	56	0
435	Reconstructed	43	20	59	87	224	2
273	Shop fabricated	209	40	2	4	0	18
2038	Riveted/bolted (in field)	58	65	80	220	1496	119
6127	Welded (in field)	555	1241	1656	1572	890	213
9197	Total	876	1376	1831	2096	2666	352

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waterway.

Mode of receipt/shipment:		R	S	Distance to navigable waters:	
Pipe line	____	1928	2030	less than 1/4 mile	321
Rail car	____	6	10	+1/4 to 1/2 mile	185
Marine vessel	____	54	52	+1/2 to 1 mile	168
Truck transport	____	431	112	+1 to 5 miles	330
Other (specify):	____	0	0	over 5 miles	1128

5. Is this facility covered by SPCC regulations (40CFR112)? yes 795 no 1337

6. Does this facility have a written spill contingency plan? yes 1699 no 433

PRODUCTION

The number of aboveground storage tanks associated with crude oil production is estimated at 572,620 for the U.S. Because of the nature of production operations, the data collection form used for the production portion of the survey requested some additional information, used somewhat different definitions of categories, and reported data on a statewide rather than a facility basis.

A total of 199 surveys representing the 31 producing states contained data on 72,409 active wells, accounting for a total monthly production of 99,421 MBbl/Mo and 54,046 AST's. Based on data reported in the Basic Petroleum Data Book (API, September 1988) the total December 31, 1987 well count for the U.S. is 615,767 (Section III, Table 18c, excluding wells in federal waters) and the corresponding 1987 U.S. crude oil production is 3,047,378 MBbl (Section IV, Table 1).

Unstratified estimation by extrapolating either on the basis of production or well counts would not yield reliable estimates. In fact, these two unstratified extrapolation methods would yield estimates which differ, with the well count extrapolation giving the higher estimate. The extrapolation based on unstratified production would be lower because of the fact that there are very few tanks at the highest production fields such as those on the north slope in Alaska.

A stratified estimate can be obtained by grouping states based on a factor related to their dominant modes of production. A major distinction exists between stripper well activity (well production below 10 Bbl/D) and non-stripper activity. Since the number of stripper well operations was not specified within the survey data, these were estimated on the basis of daily production per well. (Basic Petroleum Data Book, Section IV, Table 8c.) States were grouped according to average daily production per well. Six categories were defined as the following: under 4, 4-10, 10-40, 40-100, 100-1000 and over 1000 Bbl/D. The first group consists of operations in 11 states while the other groups consists of operations in 2, 11, 4, 2 and 1 state(s), respectively. The groups with lower than average production per well correspond to those with higher stripper well fractions. Survey forms were classified as "low production" or "stripper" if the production per well was below twice the average statewide value. This criterion was selected to minimize the discrepancy between extrapolations based on well counts versus those based on production. An exception was made for the state of Texas since the survey respondents from that state were almost entirely large companies. For Texas, forms representing average production below 18.8 Bbl/D were classified as stripper, resulting in a close match to the known 62% stripper well fraction for the state. (National Stripper Well Survey, Interstate Oil Compact Commission, 1988.)

The "stripper" (S) versus "non-stripper" (NS) distinction results in a second level of stratification. Estimates of aboveground tanks are given in Table P-1. The second level of stratification is given for the number of wells in the U.S. It was used computationally in estimating, based on the criteria described above, the total numbers of tanks in the U.S.

Table P-1

Extrapolation of production survey tanks to U.S. totals

Group	# of data forms	# of wells Survey	# of wells U.S.	Survey tanks	Estimated U.S. tanks
(1) S	6	1,031	0	155	183
NS			1,216		
(2) S	2	124	0	131	176
NS			167		
(3) S	21	2,729	15,961	2,770	22,309 *
NS			16,485		
(4) S	114	53,164	183,838	33,854	222,406 *
NS			111,679		
(5) S	20	4,762	81,592	6,565	147,755 *
NS			28,551		
(6) S	36	10,599	170,396	10,571	179,791 *
NS			5,882		
Total	199	72,409	615,767	54,046	572,620

* National estimates for groups (3)-(6) were obtained by sorting survey respondents into Stripper and Non-Stripper subgoups for each group according to the well-production average which was found to yield total group estimates based on well counts in best agreement with total group estimates based on production. Because this was an estimation-based sorting of respondents into subgroups, and not a survey counts sorting of tanks, only the total number of survey wells in each group is given in Table P-1.

Characteristics of these groupings can be compared with U.S. values. From the data in Table P-2, the number of tanks per well in the U.S. (excepting the first two groups as special cases) is consistent with a general average slightly over 1 tank per stripper well and about 1/3 tank per non-stripper well.

Table P-2

Group	Tanks per well		Production per well	
	Survey	U.S.	Survey	U.S.
(1)	0.15	0.15	663.3	581.6
(2)	1.05	1.05	75.5	67.8
(3)	1.02	0.69	16.5	16.6
(4)	0.64	0.75	8.0	5.1
(5)	1.38	1.34	4.9	1.4
(6)	1.00	1.02	0.7	0.6

Note:

The estimation of the total number of tanks in the U.S. in the production sector based on this survey is probably an under-estimate of the actual U.S. total for two reasons. First, the survey respondents from some important regions such as Texas tended to under-represent the low-production operations which have larger tanks-per-wells ratios. This was partially accounted for in the extrapolation by the stripper/non-stripper grouping, but even this may have missed some tanks associated with extremely low production wells. Second, over the last several years, many wells have been removed from the producing list but their tanks still exist. For example in the one year between January 1, 1987 and January 1, 1988, the stripper well count in Oklahoma alone dropped by 7,271. As wells within a producing lease are removed from the producing list, estimates based on producing well counts will decline while the leases may still contain some of the tanks. Although the survey did not include lease counts, a preliminary inquiry into lease figures in several of the major states indicates that the total U.S. production tank population may be as much as 900,000 if one assumes one tank battery per lease and further assumes an average of 1.5 to 4 tanks per battery depending upon production province. However, determination of both state-by-state numbers of leases and state-by-state ratios of tanks to leases would require additional data collection, which was beyond the scope of the present survey.

Table P-3

Survey totals for PRODUCTION (199 forms)

Form completed by _____ Title _____
Company _____ Phone _____
Mail address _____ City _____ State _____ Zip _____
Area Surveyed, State _____
Number of active wells in area surveyed: oil 72,409 gas 14,051
Total monthly production (thousands of barrels) 99,421

1. Indicate the number of above ground tanks serving the following functions:
   Petroleum production 52,850 Gas plants 1,196

2. Record the number of above ground tanks in this survey area according to each type of material being stored by the tank capacity range indicated (one M=thousand barrels). "Total Capacity" equals the summed capacities of all tanks with the specified material.

Total #	TYPE OF MATERIAL / Capacity in bbls	26 to 500	+500 to 1M	+1M to 3M	+3M to 10M	+10M to 100M	+100M	Total Capacity (MBbls)
28,478	Crude Oil (>16° API)	24,963	2,587	668	213	46	1	12,974
1,368	Heavy Crude Oils (<16° API)	578	173	518	86	11	2	2,723
5,949	Condensate	5,468	322	103	42	14	0	2,839
189	Lube Oils (not viscous)	177	9	3	0	0	0	67
15,235	Non-Potable/Production Water	12,208	1,834	775	382	36	0	10,329
1,569	Non-Operational Tanks	1,104	243	173	39	10	0	1,358
1,258	Other:	936	163	105	37	17	0	1,369
54,046	TOTAL	45,434	5,331	2,345	799	134	3	31,659
	TANK FOUNDATION							
2,520	Concrete Pad	1,918	312	191	80	19	0	2,335
35,197	Gravel	28,721	3,968	1,802	623	81	2	22,155
14,748	Ground	13,480	889	289	63	26	1	5,782
	CORROSION PROTECTION							
1,583	External Cathodic	927	306	210	106	32	2	2,788
4,644	Internal Cathodic	2,570	1,190	579	280	24	1	5,714
15,819	Internal Coating	12,241	2,225	856	447	47	3	12,689
3,820	Galvanized	2,123	1,128	484	82	3	0	3,444

3. Record the number of above ground tanks in this survey area according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total #	TYPE OF CONSTRUCTION / Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
1,203	Reconstructed	448	158	197	327	27	46
37,292	Shop fabricated, steel	15,125	10,047	5,998	1,415	1,016	3,691
4,385	Shop fabricated, fiberglass	3,356	787	147	18	0	77
2,410	Welded (in field)	654	912	380	126	65	273
8,504	Bolted (in field)	1,706	2,383	2,333	1,001	214	867
53,794	TOTAL	21,289	14,287	9,055	2,887	1,322	4,954

4. Enter the number of tanks for each method of shipment of crude or condensates:
   Pipeline 14,907
   Rail car 7
   Marine vessel 71
   Truck transport 22,153

   Distance to nearest river, stream, or lake (indicate number of tanks in each category)
   less than 1/4 mile 8,255
   +1/4 to 1/2 mile 5,496
   +1/2 to 1 mile 5,216
   +1 to 5 miles 11,909
   +5 miles 17,721

5. Number of tanks covered by SPCC plans Yes 30,399; No 23,489
6. Number of tanks covered by written spill contingency plans Yes 24,345; No 24,424
7. Total number of discharges from storage tanks reported in 1986 194, 1987 181
8. Number of spills from storage tanks into navigable waters 1986 12, 1987 6
9. Number of tanks located in wetlands Yes 679 No 50,035
10. Number of tanks replaced or repaired in an average year due to visible indication of leaks Yes 855 No 48,231

Table P-4. Estimated U.S. AST's for PRODUCTION

1. Indicate the number of above ground tanks serving the following functions:
   Petroleum production 561,786 Gas plants 10,834

2. Record the number of above ground tanks in this survey area according to each type of material being stored by the tank capacity range indicated (one M=thousand barrels). "Total Capacity" equals the summed capacities of all tanks with the specified material.

Total #	TYPE OF MATERIAL / Capacity in bbls	28 to 500	+500 to 1M	+1M to 3M	+3M to 10M	+10M to 100M	+100M	Total Capacity (MBbls)
313,872	Crude Oil (>16° API)	288,725	17,649	5,416	1,703	369	10	126,197
9,955	Heavy Crude Oils (<16° API)	4,600	1,137	3,380	728	93	17	20,616
50,681	Condensate	47,134	2,365	786	313	83	0	21,192
1,331	Lube Oils (not viscous)	1,223	83	25	0	0	0	496
176,039	Non-Potable/Production Water	153,215	13,590	6,256	2,721	257	0	94,181
11,945	Non-Operational Tanks	8,551	1,682	1,330	280	102	0	10,159
8,797	Other:	6,597	1,122	784	224	70	0	7,754
572,620	TOTAL	510,045	37,628	17,977	5,969	974	27	280,595
	TANK FOUNDATION							
19,576	Concrete Pad	14,849	2,531	1,509	585	102	0	16,467
335,935	Gravel	288,086	28,310	14,016	4,915	591	17	188,363
217,109	Ground	207,110	6,787	2,452	469	281	10	75,765
	CORROSION PROTECTION							
14,656	External Cathodic	9,341	2,438	1,747	838	275	17	24,522
41,689	Internal Cathodic	26,675	8,096	4,542	2,160	206	10	46,878
144,115	Internal Coating	118,895	14,642	6,850	3,405	296	27	101,652
36,190	Galvanized	23,650	8,704	3,236	587	13	0	27,045

3. Record the number of above ground tanks in this survey area according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total #	TYPE OF CONSTRUCTION / Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
11,968	Reconstructed	3,535	1,890	2,421	3,524	243	355
410,925	Shop fabricated, steel	147,958	125,794	81,867	15,305	10,603	29,398
62,839	Shop fabricated, fiberglass	43,192	13,535	5,444	158	0	510
23,733	Welded (in field)	6,210	9,198	4,816	879	583	2,047
63,155	Bolted (in field)	11,545	17,446	17,583	8,999	1,680	5,902
572,620	TOTAL	212,440	167,863	112,131	28,865	13,109	38,212

4. Enter the number of tanks for each method of shipment of crude or condensates:

Pipeline	157,881
Rail car	41
Marine vessel	524
Truck transport	209,378

Distance to nearest river, stream, or lake (indicate number of tanks in each category).

less than 1/4 mile	146,495
+1/4 to 1/2 mile	86,015
+1/2 to 1 mile	82,881
+1 to 5 miles	120,323
+5 miles	136,906

5. Number of tanks covered by SPCC plans Yes 333,093 No 239,527
6. Number of tanks covered by written spill contingency plans Yes 272,569 No 300,051
7. Total number of discharges from storage tanks reported in 1986 1,692, 1987 1,412.
8. Number of spills from storage tanks into navigable waters 1986 110, 1987 64.
9. Number of tanks located in wetlands Yes 5,353 No 567,267
10. Number of tanks replaced or repaired in an average year due to visible indication of leaks Yes 8,389 No 564,231

In addition to the national totals, the production survey data set was also analyzed for state-by-state totals. Table P-5 below gives the total number of producing oil wells as of December 31, 1987 for each producing state, the estimated ratio of the number of tanks to the total number of wells for each state based on the survey results, and the estimated number of tanks for each state. The total number of wells is that reported in the Basic Petroleum Data Book (Vol. 8, No. 3, September 1988, Sect. III, Table 18C), excluding wells in federal waters, adjusted for consistency with the Stripper Well Survey (January 1, 1988, p. 7). The variety of operational configurations at production sites in different states is reflected in the differences in tank-to-well ratios from state to state. The lowest ratio is for Alaska which is dominated by the high producing wells on the north slope with few tanks. The highest ratios are for Colorado, Montana and Ohio which have about twice the number of tanks as producing wells.

Table P-5

State	Number Producing Oil Wells: Stripper	Number Producing Oil Wells: Total	Estimated Ratio of Number of Tanks to Total Producing Oil Wells Based on Survey	Tanks
Alabama	122	875	0.618	541
Alaska	0	1,216	0.150	183
Arizona	15	28	0.571	16
Arkansas	4,438	8,398	0.966	8,109
California	26,988	45,694	0.599	27,390
Colorado	5,097	5,642	2.513	14,178
Florida	0	122	1.000	122
Illinois	31,883	32,307	0.498	16,083
Indiana	4,985	7,449	0.692	5,153
Kansas	51,953	51,953*	1.180	61,309
Kentucky	18,073	22,974	0.869	19,964
Louisiana	15,000	29,758	0.669	19,905
Michigan	3,015	4,996	1.050	5,244
Mississippi	644	2,143	0.734	1,572
Missouri	289	289*	0.500	144
Montana	3,300	4,050	1.919	7,770
Nebraska	1,589	1,852	1.122	2,078
Nevada	0	45	1.200	54
New Mexico	14,622	18,401	0.809	14,893
New York	4,221	4,428	0.484	2,142
North Dakota	1,125	3,474	1.123	3,903
Ohio	28,908	30,013	1.661	49,841
Oklahoma	77,154	101,745	1.373	139,646
Pennsylvania	13,255	14,271	0.761	10,867
South Dakota	27	149	0.776	116
Tennessee	853	853*	0.500	426
Texas	123,945	198,163	0.703	139,287
Utah	824	1,785	1.035	1,848
Virginia	51	51*	1.000	51
West Virginia	15,925	15,925*	0.867	13,810
Wyoming	3,486	10,953	0.546	5,975
TOTAL	451,787	620,002		572,620

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* Totals adjusted to stripper counts.

APPENDIX A

DEFINITIONS OF TERMS AND DATA QUALIFICATION

API Above Ground Storage Tank Survey Form DEFINITIONS:

Above ground tank: A stationary container (tank) of 1,100 gallons (26 barrels) or greater capacity that operates at pressures below 15 psia and is constructed primarily of non-earthen materials which provides structural support and whereby more than 90% of the tank volume is not buried below the ground surface. Process vessels are excluded under this definition.

Distillates: Petroleum products including intermediate stocks, naphtha, fuel oil, diesel, jet fuel, and kerosene.

Elevated tank: Storage tank not in contact with the ground, or a concrete, steel or other solid support.

Facility: A location that has one or more above ground stationary storage tanks.

Fluid heavy oils: Heavy petroleum liquids that have viscosities less than 200 SFS (Saybolt Furol Seconds) @ 100 deg C which include some crude oils, some heavy fuels (e.g., #4 fuel), and some residuals.

Gasolines: Petroleum products including gas oils, gas liquids, condensates, aromatics, natural gasoline, and motor gasolines.

Marine vessel: Ship, tanker or barge.

Navigable waters: As defined by 40CFR112.

Non-operational tank: Any above ground tank that is empty and represents excess storage capacity.

Petroleum: Includes crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees F, 14.7 psia) used for purposes as fuel, lubricants or feedstocks.

Petroleum tank: An above ground tank that stores petroleum or a mixture of regulatory substances and petroleum in which petroleum comprises greater than 50% of the weight or volume of the mixture.

Process vessel: A vessel in industrial or commercial operation in which, during use, there is a mechanical, physical or chemical change of the contained substance taking place. The industrial or commercial process may be mixing, separating, chemically altering, dehydrating, extracting, refining or polishing of the substances in the tank. The term "process vessel" does not include tanks used to store substances prior to sale or to store feedstock prior to additional processing.

Reconstructed tank: Storage tank which has been rebuilt at some point after its initial installation. This includes reassembly at a new location.

SFS: Saybolt Furol Seconds is approximately one tenth the Saybolt Universal Seconds (SUS) and is used for those petroleum products having viscosities greater then 1,000 SUS. The word "furol" is a contraction of fuel and road oils.

Storage: The containment of regulated substances to be transferred for later use. It does not include the storage of materials in treatment or industrial processing or the temporary containment of drips, spills, leaks, or other releases before they enter the environment.

Stationary: Non-mobile. Fixed or permanently in place.

Tank Capacity: Tank "shell" capacity.

Viscous heavy oils: Petroleum liquids that have viscosities of 200 SFS or more @ 100 deg C and include some crude oils, some heavy fuels (e.g., #5 and #6 fuels), asphalts, some base lube stocks, and most residuals.

DEFINITIONS:

Above ground tank: A stationary container (tank) of 1,100 gallons (26 barrels) or greater capacity that operates at pressures less than 15 psia and is constructed primarily of non-earthen materials which provide structural support and whereby no more than 10 percent of the tank volume is below the ground surface. This definition does not include process vessels, non-stationary tanks, elevated tanks, or tanks that are removed from service.

Elevated tank: Storage tank not in contact with the ground, on a concrete, steel, or other solid support.

Non-operational tank: Any above ground tank that is not in service, but can be placed in service at its location.

Process vessel: A vessel in which, during use, there is a mechanical, physical or chemical change of the contained substance taking place. The process may be mixing, separating, chemically altering, dehydrating, extracting, refining, or polishing of the substances in the tank. As examples, process vessels include separators and heater/treaters.

Reconstructed tank: Any tank which has been dismantled at one place of service and rebuilt at another. It does not include tanks that have been moved intact.

Reported discharges: Those discharges of regulated substances which, because of volume or location, were reported to the State Regulatory Office.

Spills: Those discharges that get into navigable water and reported to the EPA or Coast Guard.

Survey area: Area having one or more above ground storage tanks. Each survey area must be confined to a state.

Wetlands: Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions.

DATA QUALIFICATION

The following categories of possible error were checked for each of the submitted forms:

Category		General Percentage	Production Percentage
1	State in which facility is located is unspecified	0.7%	2.0%
2	Multiple facilities at same "site"	10.3	89.6
3	Industry function marked "other"	4.1	0.5
4	Facility thruput is missing or zero	1.2	0.5
5	Type-by-size tank counts not given numerically	0.0	0.0
6	Capacity inconsistent with tank-by-size tank counts	3.2	0.5
7	Capacity not specified	3.6	0.5
8	Incorrect totals for type-by-size tank counts	1.1	0.0
9	Units problem with thruput or capacity	2.7	0.0
10	Material-by-age tank counts not given numerically	0.1	0.0
11	Incorrect totals for material-by-size tank counts	0.5	0.0
12	No method of receipt indicated	10.0	4.9
13	No method of shipment indicated	10.3	4.9
14	Ambiguous indication as to mode of shipment vs. receipt	8.7	0.0
15	Distance to navigable waterway not specified	4.5	23.9
16	SPCC plan not indicated as Y or N	2.0	3.9
17	Spill contingency plan not indicated as Y or N	1.5	7.3
	Total number of forms	N = 1765	N = 205

Tabulated to the right is the percentage of forms which had the indicated problem on the three-stage error detection/correction procedure. Problems such as obvious entry on wrong line, incorrect subtotals, obvious wrong or inconsistent units were corrected by hand. No form was allowed to enter into the survey tabulations unless it passed without any problem of category 1, 3-6, and 8-11. Problems of categories 2, 7 and 12-17 did not disqualify a form from entry.

Two types of forms were used in the survey. The "general form" was used for petroleum marketing, refining and transportation as well as certain other categories. The second form was one specifically designed for petroleum production.

Of the 1765 general forms received, a total of 1565 (89%) passed the quality control screen. Of the 205 production forms, 199 passed the screen. In addition, 169 survey responses from PMAA members provide supplemental data for the marketing sector. In all, the survey is based on 1,933 responses covering over 76,000 tanks.

An overview of results for four industry sectors is present in Table A-1.

Table A-1

Survey overview and estimated AST populations by industry sector

Industry Sector	Units type Surveyed	Surveyed Number of Units	Surveyed Number of Tanks	Estimated National Tanks
Marketing*	Facility	564*	5,831*	88,529
Refining	Refinery	63	11,440	29,727
Transportation	Facility	1,107	5,391	9,197
Production	Company/State -operations	199	54,046	572,620
Total		1,933*	76,708*	700,073

*Includes supplemental data for PMAA member marketing operations.

Tank capacity for each individual tank size group was not specifically requested on the API survey form. Overall storage capacity by product type was usually provided by the respondents. In cases for which this datum was missing, tank shell capacity for the different groups is estimated from the schedule in Table A-2.

Table A-2

Schedule for estimating tank capacity

Indicated Capacity Range in Bbls	Estimated Average Capacity Per Tank in Bbls		
	Non-production	Production (Majors)	Production (Independents)
26 to 500	340	300	100
+500 to 1M	750	1,000	500
+1M to 3M		2,000	1,000
+3M to 10M	{5,500}	7,000	5,000
+10M to 100M	44,000	20,000	20,000
+100 to 500M	190,000	200,000	200,000
+500M	1,050,000	-	-

Tanks include five specified categories of petroleum product tanks and in addition include categories for non-potable water, non-operational and "other" tanks. The category "other" includes such products as alcohol, caustic acid, nitgrogen fertilizer, drinking water and intermix slop.

APPENDIX B

API BIBLIOGRAPHY

ENTROPY LIMITED

American Enterprise Institute, 1979: Oil Pipelines and Public Policy: Analysis of Proposals for Industry Reform and Reorganization, ed. by Edward J. Mitchell, Wash., D.C., 392pp.

A conference sponsored by the American Enterprise Institute for Public Policy Research. Historically there was discrimination by pipeline owners among shippers. This volume represents the state of the debate in 1979. Supplement 5 entitled 'Oil Pipelines: Industry Structure' by S. Morris Livingston discusses pipelines as plant facilitites. Included are tables of the percentage of product moved by pipeline in refineries, ownership of U.S. Oil Pipelines in order of refinery size and a list of refineries with pipeline (gathering) maps.

American Petroleum Institute, January 1988: Basic Petroleum Databook (Petroleum Industry Statistics), Vol VIII, No. 1 and 2, Wash. D.C.,400pp.

This compendium of data includes domestic and world statistical background information beginning with 1947. Chapter headings include: energy, reserves, exploration and drilling, production finance, prices, demand, refining, imports, exports, offshore, transporation, natural gas, and the Organization of Petroleum Exporting Countries. The Databook is updated and published 3 times a year.

American Petroleum Institute, 1984: Introduction to the Oil Pipeline Industry, ed. Nora Sheppard, Petroleum Extension Service, University of Texas, Austin, 103pp.

The manual is one of a series of books on oil pipelines. The series evolved from a single manual that was published in the 1940's and was entitled "Oil Pipeline Transporation Practices." Chapter titles are: History; Gathering Oil; Pump Station Operation; Control of the Oil Movements; Maintenance; and Products Pipelining.

American Petroleum Institute, Accounting and Statistics Department, 1986 Joint Association Survey: Survey on Drilling Costs, Finance, Wash., D.C., 83pp.

This annual report is a long-term source of information on detailed U.S. drilling expenditures. The survey, conducted since 1959 presents wells, footage, and related expenditures for each active drilling area. Data for oil wells, gas wells, and dry holes are reported separately and the information is aggregated by depth interval for each state and area. Similar summary tables are provided for the offshore and onshore areas.

American Petroleum Institute, January 1982: "Specification for field welded tank for storage of production liquids", API Specification 12D(Spec 12D), 9th ed., Wash.D.C., 22pp.

This specification covers material, design, fabrication, and testing requirements for vertical, cylindrical, aboveground, closed top, welded steel storage tanks in various standard sizes and capacities.

American Petroleum Institute, April 1985: "Recommended rules for design and construction of large, welded, low-pressure storage tanks." Incorporating Revision 1 for Standard 620, 7th ed., Sept. 1982, Wash., D.C..

American Petroleum Institute, February 1984: "Recommended rules for design and construction of large welded, low-pressure storage tanks." Revision 1 for Standard 620, 7th ed., Nov. 1980, Wash., D.C..

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American Petroleum Institute, February 1984: "Welded steel tanks for oil storage." Revision 1 for Standard 650, 7th ed., Nov. 1980, Wash., D.C..

American Petroleum Institute, Production Department, July 1987: "Specification for shop welded tanks for storage of production liquids." Spec 12F, 9th ed., Wash., D.C., 25pp.
This specification covers material, design, fabrication, and test requirements for shop fabricated vertical, cylindrical, aboveground, closed top, welded steel storage tanks in various standard sizes and capacities.

American Petroleum Institute, Statistics Department, 1981: Standard Definitions for Petroleum Statistics. Technical Report-1, 3rd ed., Wash., D.C., 46pp.
A set of definitions of the most important terms used in reporting statistical information petroleum reserves and production (Part 1), wells and drilling related to crude oil, natural gas and natural gas liquids (Part 2), and products (Part 3). Also included is a "Layman's Guide to a Typical U.S. Refinery".

American Petroleum Institute, Production Department, March 1974: Suggested Procedure for Development of Spill Prevention Control and Countermeasure Plans. Bulletin D16 1st ed., Wash., D.C., 11pp.
This bulletin applies to non-transportation onshore and offshore facilities.

Anderson, Kenneth E. and Bill D. Berger, 1978. Modern Petroleum: A Basic Primer of the Industry, Penn Well Books, Tulsa, OK, 2nd ed., 1978, 255pp.
A broad overview of all aspects of the petroleum industry for the lay person as well as those in the industry who have not had the opportunity to become familiar with operations outside their own sphere of influence.

Association of Oil Pipelines, March 1983: Oil Pipelines of the United States: Progress and Outlook. A.O.P.L. publication, Wash., D.C., 16pp.
This booklet contains information on oil pipelines: statistical highlights; crude oil pipelines; crude oil trunklines; refined petroleum products pipelines; and a discussion of marketing, economics and environmental issues.

Association of Oil Pipelines, August 1987: U.S. Oil Pipeline Factsheet. A.O.P.L. publication, Wash., D.C., 1pp.

Association of Oil Pipelines, April 15, 1987: "Pipelines and water carriers continue to lead all other modes of transport in ton-mile movement of oil in 1985". A.O.P.L. press release, Wash., D.C., 5pp.

Bureau of the Census/Department of Commerce, March 1985: 1982 Census of Manufacturers: Petroleum and Coal Products. Industry Series, MC82-I-29A, Industries 2911, 2951, 2952, 2992, and 2999, Wash., D.C., 31pp.
This report comprises establishments primarily engaged in the manufacture of fuel briquets, packaged fuel, powdered fuel, re-refined fuel oil, and other products of petroleum and coal, not elsewhere classified. There are 3 sections: Industry, Product and Material Statistics.

Bureau of the Census/Department of Commerce, February 1985: 1982 Census of Mineral Industries: Crude Petroleum and Natural Gas. Industry Series, MIC82-I-13A, Wash., D.C., 23pp.
This report is one of a series of twelve industry reports, each of which provides statistics for individual industries. The tables are divided into

four groups: Industry, Product, Material and Company size. Comparative data between 1977 and 1982 reflect the primary and secondary activities performed by the same establishments.

Bureau of the Census/Department of Commerce, October 1985: 1982 Census of Mineral Industries: General Summary. Subject Series, MIC82-S-1, Wash., D.C., 81pp.
A comprehensive statistical profile of a large segment of the national economy. Included are manufacturers, retail trade, wholesale trade, service industries, mineral industries and construction industries.

Bureau of the Census/Department of Commerce, 1985: 1982 Census of Wholesale Trade: Measures of Value Produced, Capital Expenditures, Depreciable Assets and Operating Expenses. Industry Serices, WC82-1-2, Wash., D.C..

Bureau of the Census/Department of Commerce, 1985: 1982 Census of Wholesale Trade: Miscellaneous Subjects. Industry Series, WC82-1-4, Wash., D.C., 128pp.
The tables in this statistical report are in six groupings: sales by class of customer; employment by principal activity; type of operation; sales and commissions received; and petroleum bulk stations and terminals. An appendix with explanatory notes is provided.

Bureau of the Census/Department of Commerce, May 1984: 1982 Census of Wholesale Trade Petroleum Bulk Stations and Terminals. Industry 5171, Wash., D.C., 4pp.
This booklet gives sales figures and payroll figures in the following four tables:

Industry Statistics: 1982 and Earlier Census Years
Sales of Major Commodity Lines as Percent of Total Sales (1982 and 1977)
Comparative Industry Statistics for States (1982 and 1977)
Selected Industry Ratios for States (1982 and 1977).

Bureau of the Census/Department of Commerce, November 1984: 1982 Census of Wholesale Trade: Texas. Geographic Area Series, WC82-A-44, Wash., D.C. 99pp.
The statistical reports in this booklet include: a state summary; comparative statistics of 1982-1977; selected ratios for the state; summaries for metropolitan areas, counties, etc.; and counties and places ranked by volume of sales. Appendices are included. The sales by petroleum and petroleum products wholesalers in 1982 accounted for close to 1/3 of the states sales by all wholesalers.

Colonial Pipeline Company, Sept. 1987: The Quest for Excellence (1962-1987). Atlanta, GA, 21pp.
This book is a history of the Colonial Pipeline Company. Colonial's role in the U.S. Oil Pipeline Industry is discussed. Operating and plant investment statistics are included. A Colonial Pipeline Co. system map folds out from the back page.

Independent Liquid Terminals Association: 1987 Directory: Bulk Liquid Terminals and Storage Facilities, Wash., D.C., 139pp.
The I.L.T.A. member companies are alphabetically listed. International members and non-petroleum terminals are included. Each entry includes modes served and storage tank information. (i.e. How many tanks, total capacity and range in size.) Truck facilities, dock data, commodoties handled and other facilities and services are also listed. An index of companies by state is also included.

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Independent Petroleum Association of America, January 1988: Executive Report, Volume 29, No. 1, Wash., D.C., 6pp.
This report includes the following articles on different issues concerning the Independent Petroleum Association: E.P.A. studies; Leasing reform; Lawsuits; and the U.S. and Canada Trade Agreements.

Independent Petroleum Association of America, December 1987: U.S. Energy Update, Wash., D.C., 4pp.
Various articles about the petroleum industry are contained in this booklet. The back page is a state update giving the number of wells and barrels of annual production.

Independent Petroleum Association of America: Not If...But When? The Next Energy Crisis, Wash., D.C., 16pp.
This booklet is about the independent producer and the problems entailed in the search for domestic energy resources. Each page gives a question and answer.

Independent Petroleum Association of America, 1988: United States Petroleum Statistics, Wash., D.C., 9pp.
This pamphlet contains 16 tables: Exploration, Drilling, Wells, Drilling Costs, New Reserves, Proved Reserves, Petroleum Production, Petroleum Consumption, Petroleum Supply, Imports, Natural Gas, Wellhead Prices, Petroleum Product Prices, Wellhead Value and Taxes, Financial Statistics and General Economic Data.

Interstate Commerce Commission, Bureau of Accounts, Federal Energy Regulatory Commission, December 31, 1976: Transport Statistics in the U.S.: Part 6- Pipelines. Wash., D.C., 29pp.
This summary and abstract of statistics for 1976 is compiled from the annual reports filed by the carriers by pipeline. 111 pipeline companies reported in 1976. Tables include: pipeline mileage, state summaries, number of barrels transported, traffic handled on trunk lines, number of barrels going in and out of the system and finances.

Leffler, William L., Petroleum Refining for the Non-Technical Person. PennWell Books, Tulsa, OK, 1985 2nd ed., 172pp.
This book is for those people without technical degrees who need to know the fundamentals of petroleum refining. Some of the subjects discussed include: crude oil characteristics, distilling, flashing, chemistry, cat cracking, alkylation, catalytic reforming, residue reduction, hydrocracking, gasoline blending.

Maine Department of Public Safety, November 17, 1965: Rules and Regulations Relating to Gasoline and Other Flammable Liquids. Augusta, ME, 25pp.

National Petroleum Council, June 1984: Petroleum Inventories and Storage Capacity, chaired by T.A. Burtis, Wash., D.C., 160pp.
This June 1984 report is an update of the 1979 report which assessed how much petroleum in the primary distribution system would be available in a emergency. Also determined was the total storage capacity of that system at the primary, secondary and tertiary levels. Terminals and Bulk Plants are defined. Survey methodology is discussed. Sources are those companies supplying data to the EIA and PAD data.

ENTROPY LIMITED

National Petroleum Council, December 1979: Petroleum Storage and Transporation Capacities, Vol.1: Executive Summary, chaired by Robert V. Sellers, Wash. DC, 54pp.

This report provides detailed data on the storage and transporation of oil and natural gas to assist those responsible for emergency preparedness. Each subsequent volume is discussed. Volume II: Inventory and Storage gives the number of barrels in the U.S. primary distribution system (1,517,000,000) and the number of barrels in the secondary/consumer storage (500,000,000), i.e. gasoline and distillate fuel oil. Volume III: Petroleum Pipeline gives the total miles of pipelines as of 1978 with crude, refined and LPG/NGL categories. Volume IV: Tank Cars and Trucks gives the number of vehicles suitable for carrying crude oil and petroleum products. Volume V-Waterborne Transportation Report gives total capacity of the 4,323 vessels and barges as 168.4 million barrels U.S. coastal and inland receiving facilities are also listed. Volume VI: Gas Pipeline gives the U.S. network of pipeline as 331,976 miles (excluding distribution) and 71,462 miles for field and gathering systems and 260,514 miles for transmission lines.

National Petroleum Council, December 1979: Petroleum Storage and Transportation Capacities, Vol. II: Inventory and Storage. chaired by Robert V. Sellers, 74pp.

This report was to determine the minimum operating level of petroleum inventories, that is, the inventory which is required to fill pipelines and tank bottoms as well as maintain minimal operational flexibility and is, therefore, unavailable in an emergency; the total primary storage capacity for the U.S. and that portion of storage capacity which is required for normal operations and could not be used to store petroleum for an emergency; the capacity of storage facilities under construction; the nature of the relationships between primary, secondary and consumer storage; and to determine the nature of the petroleum distribution system. Also included in this volume is a discussion of the Strategic Petroleum Reserve.

National Petroleum Council, December 1979: Petroleum Storage and Transportation Capacities, Vol. III: Petroleum Pipeline, chaired by Gordon D. Kirk, 179pp.

The majority of this report consists of pipeline maps of the U.S. crude oil gathering lines (private lines not included). Gathering lines are those found in crude oil producing areas. Existing gathering systems contain approx. 67,800 miles of pipelines. Private lines are considered to be plant facilities which move petroleum between refineries and product distribution terminals or water terminals. The maps are organized by PAD districts. Pipeline company names are in Appendix 1. The sources for the maps are American Petroleum Association and the Petroleum Publishing Company.

National Petroleum Council, December 1979: Petroleum Storage and Transportation Capacities, Vol. IV: Tank Cars/Trucks. chaired by Walter B. Smith, Jr., 77pp.

This report provides a demographic breakdown and a geographic analysis of the U.S. rail tank car fleet. There are 107,552 tank cars with 2.2 billion gallon capacity which can carry crude oil and petroleum products in a national emergency. The number of tank vehicles was determined to be 50,000 with a total capacity of about 364 million gallons. The sources for this report are the Association of American Railroads and the Interstate Commerce Commission.

ENTROPY LIMITED

National Petroleum Council, December 1979: Petroleum Storage and Transporation Capacities, Vol. V: Waterborne Transportation. chaired by Charles J. Lullen.
The purpose of this report was to determine the transportation capacities as part of the federal governments overall review of emergency preparedness planning. Included is a list of major petroleum receiving facilities organized as either U.S. coastal or U.S. inland with specifications as to whether it is a refinery, plant distribution terminal or a combination thereof. Sources for statistical data are the Maritime Administration, U.S. Coast Guard, U.S. Army Corps of Engineers and American Waterways Operators, Inc.

National Petroleum Council, December 1979: Petroleum Storage and Transportation Capacities, Vol VI: Gas Pipeline. chaired by L.E. Hanna, Inc.
In lieu of emergency preparedness planning, this report is a compilation of gas flow data. It lists underground storage fields by state, county and field name. Daily and annual delivery capacities are reported. Major pipeline interconnections and their delivery capability are featured. Interconnections are by company (who receives it and who delivers it). Sources include U.S. Department of Energy, The American Gas Association and the Oil and Gas Journal.

1986:National Petroleum News Factbook - Annual issue. ed. by Marvin Reid, National Petroleum News publication, Des Plaines, IL.
Various components of the Petroleum Industry are discussed: annual reports; automotive; fuel oil; prices; storage capacity; supply and demand; taxes; distribution; and refineries. An index lists subject matter alphabetically. There are many charts and tables providing statistical data. A list of associations and marketing management personnel is included.

National Petroleum Refiners Association, January 1, 1987: United States Refining Capacity. a N.P.R.A. publication, Wash., D.C., 29pp.
This summary is taken from the Department of Energy's Petroleum Supply Annual 1986. The 12 statistical tables on refineries include: number and capacity of refineries by PAD district and state; production capacity by PAD and state; capacity by state; crude oil distillation capacity by largest company first and state; downstream charge capacity; working and shell storage capacity; refinery receipts of crude oil; fuels consumed at refineries; and refinery status and sales.

New York State Department of Environmental Conservation, Division of Water, Bureau of Spill Prevention and Response, March 1987: Recommended Practices For Aboveground Storage of Petroleum Products. Fred C. Hart Associates, Albany, NY, 121pp.
This manual presents a series of guidelines and recommended practices for the aboveground storage of petroleum products. It encourages the use of technology and practices which would prevent leaks and spills from aboveground storage systems by presenting proper storage practices. There are many charts, diagrams and photos with selected components of aboveground tanks analyzed.

New York State Department of Environmental Conservation, Division of Water, December 27, 1985: Petroleum Bulk Storage, Albany, NY, 35pp.
This booklet describes the following New York regulations:
6NYCRR Part 612: Registration of Petroleum Bulk Storage Facilities;

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6NYCRR Part 613: Handling and Storage of Petroleum;
6NYCRR Part 614: Standards for New and Substantially Modified Petroleum Storage Facilities.

New York Department of Environmental Conservation, Division of Water, October 1987: Proposed Chemical Bulk Storage Regulations. Albany, NY, 83pp.
This publication contains the following proposed regulations:
Part 595: Spills of Hazardous Substances - Reporting, Response and Corrective Action;
Part 596: Registration of Hazardous Substances Bulk Storage Tanks;
Part 597: List of Hazardous Substances.

Oil and Gas Journal, November 23, 1987: Pipeline Economics Report. Volume, 85, No. 47, Energy Group of PennWell Publishing, Tulsa, OK 96pp.
The Oil and Gas Journal's Pipeline Economic Report provides construction cost trends and project cost details on a wide variety of liquids and gas systems, both onshore and offshore. It also features comprehensive operating and financial data on U.S. liquids and natural gas pipeline companies.

Oil and Gas Journal, January 26, 1987: "Forecast Review." Vol. 85, No. 4, p. 41 PennWell Publishing, Tulsa, OK.
This review explores increases in U.S. energy demands; the fall of crude production; increase in imports and gas consumption; refinery utilization rate increases; and gains in well completions.

Oil and Gas Journal, March 21, 1988: "Annual Refining Survey" Vol. 8.
The Annual Refining Survey gives a rundown of recent refinery trends and provides a list of operating refinery data for the U.S.

Oil and Gas Journal, Energy Database, October 1987: 1987 Energy Statistics Sourcebook, PennWell Books, Tulsa, OK, 445pp.
The 1987 Sourcebook provides 1500 key data and statistical series from the Oil and Gas Journal Energy Database. There are international, national and state data in monthly and/or annual formats. The information is organized by industry segment: Exploration and Drilling, Production, Reserves, Refining, Stocks, Imports-Exports, Demand and Consumption, Natural Gas, Price, Revenues, etc.

Oil Buyers Guide, 1987: Petroleum Marketers Handbook, ed. by Joya Thompson, Petroleum Publications, Lakewood, NJ, 325pp.
This handbook gives a list of Petroleum Storage Facilities that are organized by state. Each listing has the following information: company, terminal location, storage capacity, products stored, and serviced by. 564 U.S. companies are represented along with Canada and overseas. A profile of north american utilities and the fuel oil needs of the 96 U.S. companies are organized by state. Information supplied includes: company, affiliates, fuel oil buyer, supplier, estimated consumption and purchasing information. Also included are: a Brokers and Traders Directory; Energy Future Brokers List; an OPEC price chart; and, a profile of North American Utilities and Petroleum Refineries.

Petroleum Independent, September 1987: "The oil & gas producing industry in your state." ed. by Joe Taylor, Independent Petroleum Association of America, Wash., D.C.

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This is the special statistical issue of Petroleum Independent, the official magazine of the Independent Petroleum Association of America. Statistics by state give background information; value of oil and gas; 1986 industry statistics; latest data of 1985 and a state energy contact. A map of counties with oil and/or gas production for each state is also supplied. Other chapters include: Exploration & Drilling; Producing Wells; Production; Stripper Wells; Financial; Demand; Prices; Miscellaneous; Statistical Summary and Reference Information.

Petroleum Information, 1988: Resume 1987: The Complete Annual Review of Oil and Gas Activity in the United States. a Petroleum Information publication, Denver, CO, 355pp.
National and regional statistical overviews are combined with data developed by Petroleum Information on wells. Production, development drilling expenditures and exploration are discussed. A listing of all successful exploratory wells reported complete in 1987 is broken down by regions in each state. Information includes: discovery type and field, operator, well name, location, producing formation, total depth and initial potential. Sources: American Association of Petroleum Geologists, Independent Petroleum Association of America, American Petroleum Institute and Mid-Continent Oil and Gas Association.

Petroleum Marketing Management, Vol. 10, No. 2, ed. by Louise Classon and Camille Floyd, Graphics Concepts, Rockville, MD, 54pp.
This bi-monthly publication contains feature articles on petroleum issues. A 1988 Petroleum Marketers Buyers Guide and Manufacturers Index is included. It is supplemented by a section listing the regional offices and representatives of the manufacturers of petroleum equipment.

Petroleum Marketers Association of America, 1987: 1986:Petroleum Marketing Databook, ed. by M.W. Addison, Petroleum Marketing Education Foundation, Wash., DC, 66pp.
This is an annual view of the network of Independent Petroleum Marketer. It explains economic variables so the statistics contained here can be used by the lay person. The financial data is segregated by size of company and type of operation. Representative statements of income, retained earnings, cash flow and balance sheets are presented for size and type of operation. A list of oil companies reporting to the E.I.A. and a list of refineries by size (barrels per calender day) is included. Source: 1984 Petroleum Supply Annual.

Stalby's Petroleum Terminal Encyclopedia 1986-1987. ed. by Jack E. Stalsby and Orville Wilson, Stalsby/Wilson Press, Houston, TX, 1986, 316pp.
Terminal listings in the United States are indexed by state and city. Each entry provides information on the following: company, type of terminal, address, method of shipment to and from, total capacity (some entries have number of tanks and size range), berth, and type of product. An appendix provides each listing by state, city-company and by company-state, city. Approximately 814 terminal are listed in the U.S.

Steel Tank Institute, April 1988: Tank Talk. Vol. 3, No. 4, ed. by Jim Wisuri, Brian C. Donovan, publisher, Northbrook, IL 8pp.
Tank Talk, a monthly bulletin published by the Steel Tank Institute, discusses various aspects of the tank industry (i.e legislation, corrosion,

underground storage tanks). Of particular interest is an article by Pat O'Conner "Congress Reacts to Above-Groud Storage Tank Disaster!" (p.7), an article describing the bills introduced in Congress that would regulate aboveground storage tanks.

U.S. Congressional Record, February 1, 1988: A Bill S2020. Vol. 134, Wash. D.C. This bill regulates Aboveground Storage Tanks having the capacity to store at least one million gallons of petroleum.

U.S. Department of Energy/Energy Information Administration, Office of Statistical Standards, August 1987: An Assessment of Quality of Selected EIA Data Series - Petroleum Supply Data. DOE/EIA-0292(86), Wash., D.C., 63pp.
A portion of the data in the Petroleum Supply Reporting System is analyzed in terms of its strengths and weaknesses. This report focuses on reconciling the differences in the import figures. The imported products include crude oil, motor gasoline, distillate, and residual fuel oil, for 1983 to 1986, with the emphasis on 1985 data. In addition, this report updates comparisons with other sources for series such as product supplied, stocks and production of petroleum products.

U.S. Department of Energy/Energy Information Administration, February 1988: Annual Report to Congress 1987. DOE/EIA-0173(87), Wash., D.C., 66pp.
The activities and publications of the EIA during 1987 are described. A general overview is first provided followed by a description of selected EIA 1987 statistics and facts. The appendices list EIA data gathering surveys, models and publications.

U.S. Department of Energy/Energy Information Administration, October 1987: Directory of Energy Data Collection Forms. DOE/EIA-0249(87), Wash., D.C. 68pp.
A listing of the energy information gathering forms approved for use by the U.S. Department of Energy on October 1, 1986 is provided. For each form, a descriptive abstract and the data collected are given. Appendices list forms by energy source and function; by resulting publication; and by respondent category.

U.S. Department of Energy/Energy Information Administration, May 1987: EIA Publications Directory 1986: A User's Guide. DOE/EIA-0149(86), Wash. DC, 119pp.
Lists all the 1986 EIA publications by subject, title, and report number. The abstracts of the publications are arranged by broad subject categories.

U.S. Department of Energy/Energy Information Administration, 1986: Energy Facts 1986. DOE/EIA-0469(86), Wash., D.C., 55pp.
Domestic and international energy data during 1973 through 1986 is provided in this reference booklet. Each chapter contains an overview for each energy source (petroleum, natural gas, coal, electricity, nuclear and world summary). A glossary and list of source publications are included. There are many charts and graphs.

U.S. Department of Energy/Energy Information Administration, December 1987: Energy Information Directory. DOE/EIA-0205(88/1), Wash., D.C., 96pp.
This publication lists the government offices that are involved in energy matters. The offices are classified according to their specialties. The subject guide uses an alphanumeric identification symbol for each office instead of page numbers in refering the reader to relevent entries.

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U.S. Department of Energy/Energy Information Administration, Office of Oil and Gas, December 1987: Oil and Gas Field Master Code List. DOE/EIA-0370(87), Wash., D.C., 659pp.
Standardized codes and spellings for each oil and/or gas field in the United States is provided. A user's guide, glossary, and Oil and Gas Field Code Master List, index and invalid field record list are also included. The list is organized by state. Each field name entry contains the field code, field name, geographic information, discovery year, field type, and other related information. The Field Code Index is an abbreviated listing, sorted by field code. Survey forms using these codes are listed also.

U.S. Department of Energy/Energy Information Administration, Office of Oil and Gas, December 1987: Petroleum Marketing Annual 1986. DOE/EIA-0487(86), Wash, D.C. 380pp.
Petroleum product marketing data are reported for each month of 1985 and 1986 and yearly averages from 1978 through 1986. Covered are summary statistics, crude oil prices, sale prices of petroleum products, sales volumes, and first sales of petroleum products for consumption. These data are displayed by state and PAD district, with U.S. totals/averages. (49 tables, 11 figures)

U.S. Department of Energy/Energy Information Administration, January 1988: Petroleum Marketing Monthly. DOE/EIA-0380(88/01), Wash., D.C., 176pp.
Petroleum product marketing data are reported for the U.S., PAD districts, and each state for January 1988, December 1987 and January 1987. Sales figures by type of seller and type of sale are shown for 16 individual petroleum products. Crude oil price tables, explanatory notes, a glossary and a product guide to tables are included. (75 tables, 17 figures)

U.S. Department of Energy/Energy Inforamtion Administration, May 1987: Petroleum Supply Annual 1986, Vol 1. DOE/EIA-0340(86)1, Wash., D.C., 156pp.
Information on the supply and disposition of crude oil and petroleum products is provided for the year 1986. This volume contains two sections: petroleum supply summary and refinery capacity. Detailed supply tabulations include: production, natural gas processing, refinery operations, imports and exports, stocks, transportation, and residual fuel oil by sulfur content. The refinery tabulations are given for listings of facilities and associated capacities in each state. These include summaries of corporate refinery capacities and refinery storage facilities. (64 tables, 21 figures)

U.S. Department of Energy/Energy Information Administration, June 1987: Petroleum Supply Annual, Vol. 2, DOE/EIA-0340(86)2, Wash., D.C., 440pp.
Final petroleum supply statistics for each month of 1986 are presented, replacing data previously published in the Petroleum Supply Monthly. Covered are national statistics; supply and disposition of crude oil and petroleum products by PAD district; production of crude oil and lease condensate; natural gas processing; refinery operations by PAD district; imports and exports; stocks; transportation between PAD districts and residual fuel oil by sulphur content. (28 tables)

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U.S. Department of Energy/Energy Information Administration, September 1987: Petroleum Supply Monthly. DOE/EIA-0109, Wash., D.C., 120pp.

Summary data on U.S. supply, disposition, and stocks of crude oil and petroleum products are reported for each year from 1973 through 1986, with monthly data shown from 1985 through September of 1987. Detailed statistics are provided for the most recent month of 1987. Shown are supply, disposition and stocks for each PAD district with U.S. totals; production of crude oil and lease condensate by PAD district and state; natural gas processing; refinery operations by PAD district; imports/exports; etc. (41 tables, 12 figures)

U.S. Department of Energy/Energy Information Administration, Office of Energy Markets and End Use, April 1987: State Energy Data Report - Consumption Estimates 1960-1985. DOE/EIA-0214(85), Wash., D.C., 470 pp.

This report presents estimates of annual energy consumption at the state and national levels by major economic sector and by principal energy type of 1960 through 1985. Included in the report are: documentation describing how the estimates were made for each energy source; sources of all input data; and a summary of changes from the State Energy Data Report published in April 1986.

U.S. Department of Transporation, Materials Transport Bureau, September 10, 1982: Liquid Pipeline Directory, by G.A. Daye and G.V. Miller, Wilson Hill Associates, Wash., D.C., 642pp.

The scope of this directory is only liquid pipelines which transport crude oil, petroleum products, anhydrous ammonia or liquid gas within the continental U.S. (Hawaii, Alaska, and Puerto Rico are included). The directory is divided into interstate pipelines and intrastate pipelines. Each entry lists pipeline name, address, phone, operator name, pipeline type, diameter, responsible region, state, liquids transported, pipeline location (beginning and end points), and intermediate points. The appendix provides alphabetical listings of pipeline by responsible region and by state.

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